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Can Rising Housing Prices Explain China's High Household Saving Rate? *

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Abstract: China's average household saving rate is one of the highest in the world. One popular view attributes the high saving rate to fast rising housing prices and other costs of living in China. This article uses simple economic logic to show that rising housing prices and living costs per se cannot explain China's high household saving rate. Although borrowing constraints and demographic changes can help translate housing prices to the aggregate saving rate, quantitative simulations using Chinese data on household income, housing prices, and demographics indicate that rising mortgage costs contribute at most 5 percentage points to the Chinese aggregate household saving rate, given the down-payment structure of China's mortgage markets.

Keywords: Chinese Economy, Housing, Saving Rate, Borrowing Constraints.

JEL Codes: D14, D91, E21, I31, R21

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1 Introduction

According to Friedman's (1957) permanent income hypothesis, rational consumers should save less when their income is growing faster, because the need to save is reduced when people expect to be richer in the future than they are today. However, the reality in China is the opposite: As one of the fastest-growing economies, China's average household saving rate is among the highest in the world.

Aggregate household saving rate is defined in this paper as the ratio of net changes in aggregate household financial wealth (e.g., bank deposits, government bonds, and stocks) to aggregate household disposable income. [1] Figure 1 shows that the average Chinese household saving rate was around 2% in 1978 (the starting year of economic reform) and rose rapidly thereafter. The saving rate stabilized around 20% to 25% after the early 1990s and peaked in 1994 and 2003 with values of 27% and 26%, respectively.

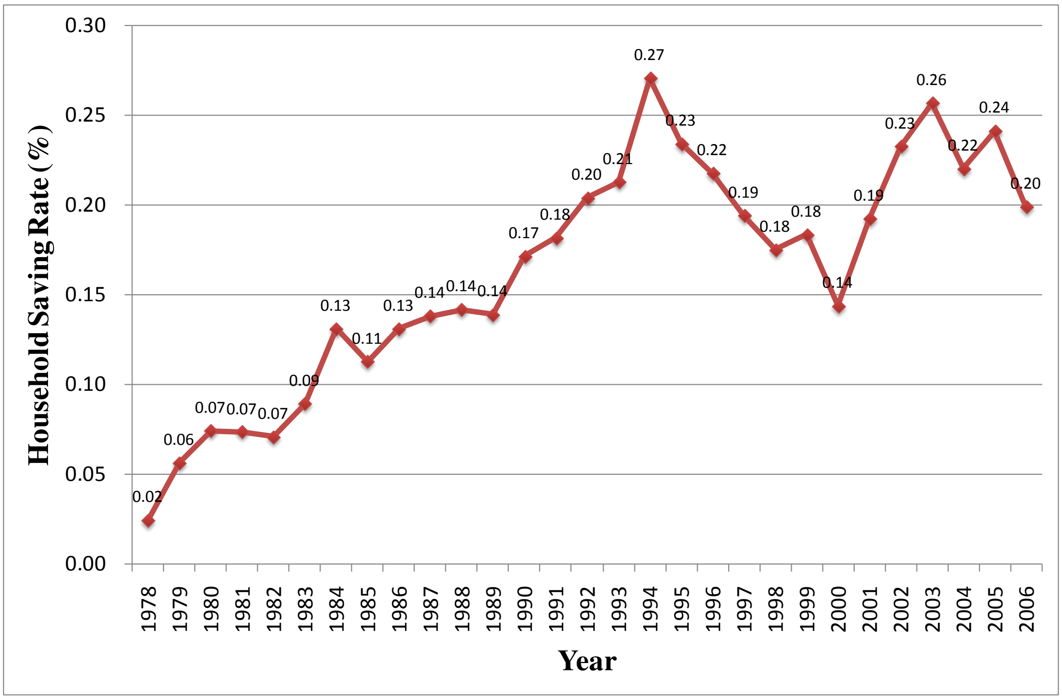

Figure 1. Chinese Household Saving Rate (1978-2006) [2]

Such a high aggregate household saving rate is extraordinary compared with

[1] Notice that our definition of the saving rate does not include changes in household nonfinancial wealth (such as housing investment).

[2] Data source: Bai and Qian (2009).

developed nations such as the United States, which has had an average household saving rate of 2% since the early 1990s (Figure 2).[3] However, the high Chinese saving rate may not be unique. Figure 2 also shows the household saving rates for Japan from 1968 to 1976 and Korea from 1983 to 1991 when these two economies experienced similar economic growth and had household saving rates similar to China.[4]

Why the Japanese saved so much during the rapid stage of economic development is still an open question (see, e.g., Hayashi, 1986). Hence, it is not surprising hat the high Chinese saving rate appears puzzling, especially given China's rapid income growth.

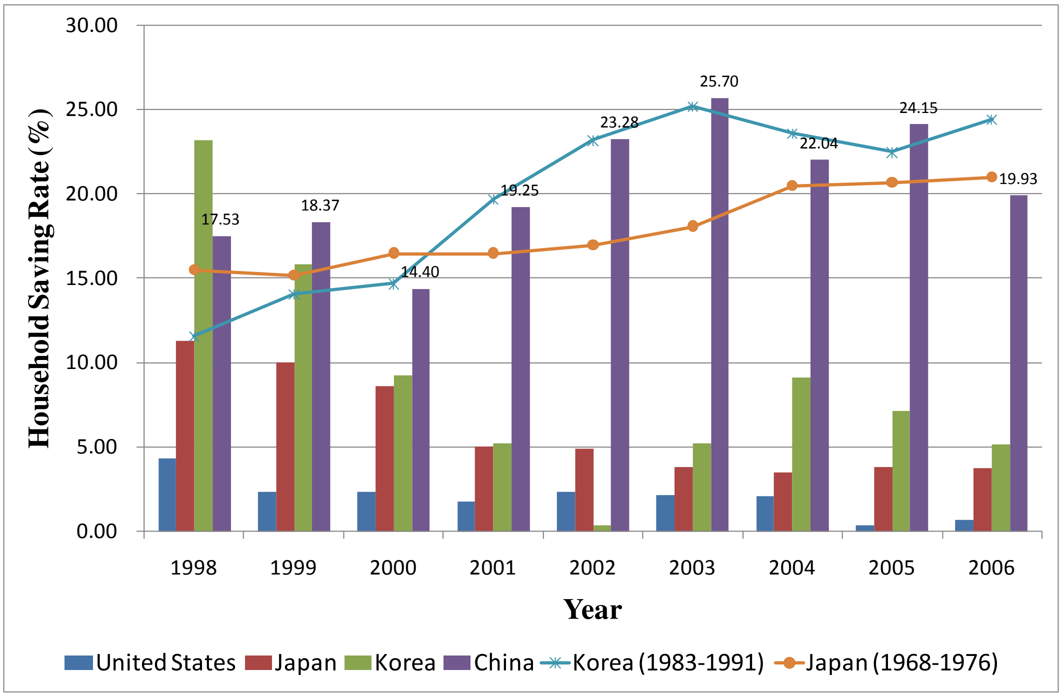

Figure 2. Cross-Country Comparison of Household Saving Rates (1998-2006)

The high saving rate of Chinese households not only poses a challenge to economic theory, but also has become a source of recent political controversy and

[3] Data source: OECD Economic Outlook 1985 database, Hayashi (1986), and Bai and Qian (2009).

[4] We are unable to find reliable household saving data for India. However, according to a report from the Centre for Monitoring Indian Economy, India's household saving rate in 2001 was 24%, including investment in nonfinancial wealth. This number rose to 34.8% in 2007, 36% in 2008, and was expected to be 24% in 2009. Based on such information, India's household saving rate has reached a level similar to China's.

trade disputes with the United States and other major trading partners of China. For example, the former chairman of the Federal Reserve, Alan Greenspan, alleged that the high Chinese saving rate was the culprit of the recent American subprime mortgage crisis because it caused low interest rates in the world financial markets, which pushed Americans toward excessive consumption and housing finance.[5]

What are the causes of the high Chinese saving rate? A growing literature has attempted to understand this phenomenon and many factors have been proposed as possible causes, including rapid income growth, aging population, lack of social safety nets and unemployment insurance, precautionary saving motives, cultural tradition of thrift, high costs of education and health care, and rising housing prices, among others.[6] In particular, Wei and Zhang (2009) propose that the unbalanced sex ratio in China leads to competitive saving behavior in the marriage markets, which may significantly raise the aggregate household saving rate because men with adequate wealth accumulation (e.g., enough savings to buy houses) have a greater chance to attract marriage partners. Such competitive behavior further drives up housing prices and reinforces the competitive saving behavior. Chamon and Prasad (2010) argue that the rapidly rising private burden of housing, education, and healthcare are the most important contributing factors. They also conjecture that the impact of these factors on saving can be amplified by underdeveloped financial and credit markets.

Indeed, the rapidly rising housing prices and other costs of living (such as education and healthcare) in China have become serious socioeconomic problems and attracted much attention from the news media and policymakers. In the cities of Beijing and Shanghai, for example, the average housing price-to-income ratio (for a 300-square-foot living space) is about 12.[7] Namely, a young married couple needs to save their entire income (a 100% saving rate) for 12 years to afford a 600-square-foot

[5] From a speech by Alan Greenspan, "The Fed Didn't Cause the Housing Bubble," Wall Street Journal, March 1, 2009.

[6] This literature includes Modigliani and Cao (2004), Carroll, Overland, and Weil (2000), Horioka and Wan (2007), Chen, Imrohoroglu and Imrohoroglu (2006), Yuan and Song (1999, 2000), and Wen (2009).

[7] According to the China Statistical Yearbook (2007), in 2006 the average living space per person was 27.1 square meters in urban areas and 30.7square meters in rural areas. However, the average living space for new homebuyers is greater than 30 square meters.

apartment for their family.[8] This means that, even with bank loans with a one-third down-payment arrangement and a 33% household saving rate, a typical working couple still needs to save for 12 years to buy a small apartment. Hence, it is not surprising that rising housing prices have been perceived as one of the most important factors underlying China's high aggregate household saving rate.

Can rising housing prices really explain the high household saving rate in China? This is not only an empirical question, but also a theoretical one with broad implications for developing economies. To the best of our knowledge, little theoretical work has been done to carefully and quantitatively address this question. Based on simple economic logic and quantitative analysis, our answer to the above question is "No."

More specifically, we show the following:

● In the absence of economic growth and borrowing constraints, the aggregate household saving rate of an economy is independent of housing prices.

● Only under the following combined conditions—namely (i) agents are severely borrowing constrained with zero possibility of obtaining mortgage loans, (ii) the relative population of would-be homebuyers to homebuyers increases rapidly over time, and (iii) housing prices rise much faster than household income—will high housing prices significantly increase the aggregate household saving rate. However, these conditions are inconsistent with Chinese reality. Quantitative simulations based on Chinese time-series data for household income, housing prices, demographic structure, and mortgage down-payment requirement show that rising housing prices can contribute at most 5 percentage points to the aggregate saving rate.

The intuition is simple: Suppose the only reason to save is to buy a house. Regardless of the level of housing prices, income saved for future housing purchases by would-be homeowners is always canceled by housing expenditures of homebuyers in the measured aggregate saving ratio. In other words, as soon as a person spends his

[8] According to China Statistical Yearbook (2008), in 2007 the nationwide average housing price was 3,645 yuan per square meter, 10,661 yuan for Beijing and 8,253 yuan for Shanghai. In 2007, the average disposable income per capita was 13,786 yuan nationwide, 21,989 yuan in Beijing and 23,623 yuan in Shanghai. Hence, if the living space per person is 30 square meters, the housing price-to-disposable income ratio would be 7.93 for the nation, 14.55 for Beijing, and 10.48 for Shanghai.

or her past savings to purchase a good, the average lifetime saving rate for that individual immediately becomes zero. If part of the expenditure is financed by bank loans against the buyer's future income, the average lifetime saving rate at the moment of the home purchase is even negative because the buyer must continue to save in the future to repay the loans until the debt is completely repaid. Hence, if the population is not growing and housing prices are constant, the aggregate saving rate across all cohorts at any point in time is independent of housing prices, regardless of borrowing constraints.

On the other hand, if housing prices are rapidly growing, then the population share of would-be homebuyers is effectively increasing relative to that of the homebuyers. In this case, the expenditures of the homebuyers cannot completely cancel the savings of the would-be homebuyers. Because young cohorts need to save more and for longer periods under borrowing constraints when housing prices increase, this is equivalent to a continuous expansion of the population size of the saving cohort relative to the dissaving cohort. In other words, both housing-price growth and borrowing constraints are equivalent to population growth in terms of their impact on the aggregate saving rate. We call such equivalence the "population effect" in this paper. Under such population effects, housing prices may play an important role in determining the aggregate saving rate. However, if household income increases at roughly the same rate as that of housing prices (as is the case in China), then the anticipated rising permanent income would reduce the need to save and cancels the population effects. In fact, the rapid growth in household income is the most important driving force behind the rapidly rising housing prices in China.

Therefore, our analysis clarifies a popular confusion or misunderstanding that attributes the high aggregate household saving rate in China to rising housing prices and other costs of living. The same logic can also be applied to discredit similar theories that view the rising private burden in education, childbearing, healthcare, marriage, and so on in China as the key contributing factors to China's high aggregate household saving rate.

Our analysis also reveals a potential tension between survey data and economic analysis. Suppose survey data unambiguously indicate that living-cost factors are the primary motive for each household to increase its saving rate. Such empirical facts by no means imply that rising living costs are responsible for the persistently high aggregate household saving rate—because incomes saved for any spending needs will always be consumed at later stages of life. Hence, such types of savings will cancel across households among different cohorts. Even if savings are not entirely spent within a person's lifetime and become bequests, they would reduce the children's need to save by exactly the same amount. Thus, any such type of savings should be canceled through aggregation across age cohorts.

Hayashi's (1986) article, "Why Is Japan's Saving Rate So Apparently High?" analyzes the possible causes of Japan's high household saving rate in the 1960-70s. His analysis includes discussions regarding the possible impact of rising housing prices on Japanese household saving behavior. In particular, using regression analysis, he found that the average household saving rate of a given Japanese city is independent of that city's average housing prices.[9] Based on this finding, Hayashi concludes that rising housing prices per se are not the cause of Japan's high household saving rate because of the "saving-expenditure cancellation" effects across population and cohorts. This conclusion is similar to ours. However, Hayashi did not conduct detailed theoretical analysis to rigorously prove the point, so his analysis is not generalizable and may not apply to China. In particular, he did not consider the possibility that under severe borrowing constraints rising housing prices may significantly increase the aggregate household saving rate.

In this paper, we choose a simple consumption-saving model to illustrate our points, yet without the loss of generality. In the model, many variables (such as household income, housing prices, the optimal age of homebuyers, and the demographic structure) are deliberately kept exogenous so that comparative statistics

[9] Hayashi also estimated the saving rates of homeowners, would-be homebuyers, and non-homeowners who do not plan to own houses in rural and urban areas, respectively. He argued that if housing prices have significant impact on a household's saving rate, then the saving rate of would-be homebuyers should be significantly higher than the other two types of households, and urban households should have a higher saving rate than rural households. But he did not find such differences in the Japanese data.

can be easily conducted using Chinese data. The only endogenous optimization behavior derived from the model is consumption smoothing over a person's lifetime subject to borrowing constraints. This framework provides the simplest setup to calibrate the model using various Chinese time-series data.

The remainder of the paper is organized as follows. Section 2 presents a benchmark consumption-saving model without borrowing constraints and studies the effects of housing prices on aggregate household saving rate. Section 3 extends the analysis to borrowing constraints. Sections 4 and 5 conduct robustness analysis and consider other extensions of the basic model. Section 6 concludes the paper with some policy recommendations.

2 The Basic Model

2.1 Constant Income and Housing Prices

Suppose shelter (housing) is an indivisible and necessary consumption good. Given income, increases in housing prices will force individual consumers to save more (and for a longer period) to afford a house. This positive association between housing prices and individual saving behavior may be why people view rising housing prices as a cause of the high aggregate saving rate in China. However, this view suffers from the fallacy of aggregation: It ignores the fact that when people purchase houses, they generate negative savings to society, canceling other people's positive savings.

More specifically, suppose that (i) the interest rate is zero and there is no discounting in the future,[10] (ii) each individual's only purpose for saving at a young age is to buy a house in middle age, and there are no debts or bequests at birth or after death. Clearly, in such a society each person's average lifetime saving rate should be exactly zero. Although a higher housing price will increase an individual's saving rate before purchasing a house, it does not change the average lifetime saving rate because at the moment of home purchase, all of the buyer's positive savings are exactly

[10] Our results are robust to these assumptions.

canceled by the current expenditure. Therefore, if the population is stable over time (i.e., each age cohort has the same number of individuals), then the aggregate saving rate is also zero, independent of housing prices.

Formally, imagine an economy where all agents have the same momentary utility function, and a typical consumer lives for T periods with a constant income flow $\overline{Y}$ in each period. The consumer needs to buy a house in period $t+1 \leq T$,[11] the price of a house is $M > \overline{Y}$, and there are no borrowing constraints except the zero-debt requirement at the end of life. Naturally, we also need to assume $T\overline{Y} > M$ to ensure that each consumer is able to afford a house with his or her lifetime income. Under these conditions, because of the zero interest rate and no discounting, the marginal utility of consumption (C) is exactly the same across time, so utility maximization implies that the consumer will save a constant amount of his or her personal income flow each period to smooth consumption.

Formally, the maximization problem is stated as:

$$\max : \sum_{\tau=1}^{T} u\left(C_{\tau}\right)$$

$$\text{s.t.: } \sum_{\tau=1}^{T} C_{\tau} - M \leq T\overline{Y}.$$

Notice that we have deliberately omitted housing consumption in the utility function to simplify the analysis. This is an innocuous assumption because shelter is a necessary consumption good and the wealth effect generated from a house, if exists, will only decrease the incentive for saving rather than increase it. The optimal solution to the above program is

$$C_{\tau} = \overline{Y} - \frac{M}{T}.$$

That is, consumption is perfectly smoothed and equals a constant. However, notice that the total expenditure in period $t+1$ equals consumption plus the housing

[11] Because t can take arbitrary values, we can calibrate it using Chinese data. Making it endogenous complicates the analysis dramatically without additional gains. An additional advantage of keeping t exogenous is that we need not worry about how and when housing enters the utility function. That is, we can ignore the utility value of housing without loss of generality.

expenditure: $C_{t+1} + M$. This typical consumer's expenditure, savings, and saving rate in each period of his/her lifetime are reported in Table 1.

Table 1. Individual Consumer's Saving Behavior

Period	***1***	**…**	***t***	***t+1***	***t+2***	**…**	***T***
Expenditure	$\overline{Y} - M/T$	…	$\overline{Y} - M/T$	$\overline{Y} - M/T + M$	$\overline{Y} - M/T$	…	$\overline{Y} - M/T$
Savings	M/T	…	M/T	$\frac{M}{T} - M$	M/T	…	M/T
Saving Rate	$\frac{M}{T\overline{\overline{Y}}}$	…	$\frac{M}{T\overline{\overline{Y}}}$	$\frac{M}{T\overline{\overline{Y}}} - \frac{M}{\overline{\overline{Y}}}$	$\frac{M}{T\overline{\overline{Y}}}$	…	$\frac{M}{T\overline{\overline{Y}}}$

The first row of Table 1 indicates the consumer's living period (or age), the second row total expenditures in each period, the third row additional savings in each period, and the last row saving rate in each period, which is defined as the ratio of additional savings to income.

Notice that the consumer's saving rate is always $\frac{M}{T\overline{\overline{Y}}}$ in each period except in period $t+1$. In period $t+1$, because of the additional spending on the housing purchase, the saving rate is negative, $\frac{M}{T\overline{\overline{Y}}} - \frac{M}{\overline{\overline{Y}}} < 0$. The consumer's average lifetime saving rate is given by

$$\text{Life-time Average Saving Rate} = \sum_{\tau=1}^{T} \frac{M}{T\overline{\overline{Y}}} - \frac{M}{\overline{\overline{Y}}} = 0. \tag{1}$$

Because the negative savings incurred at the moment of a home purchase exactly cancel the other periods' positive savings, housing prices are irrelevant to the consumer's lifetime saving rate.

To compute the aggregate household saving rate in this economy with many different age cohorts for a particular period, we need to aggregate the saving rate of each age cohort in that period. There exist two measures (or definitions) of the aggregate saving rate:

(i) The average of the personal saving rate across cohorts weighted by the population share of each age cohort—namely,

$$\overline{S}=\sum_{\tau=1}^{T}\alpha_{\tau}s_{\tau}\,, \tag{2}$$

where α_{τ} represents the population share of cohort τ in the total population, and $s_{\tau}=\dfrac{S_{\tau}}{Y_{\tau}}$ represents the saving rate of cohort τ.

(ii) The ratio of aggregate saving to aggregate income in the same period:

$$\overline{S}=\frac{\sum_{\tau=1}^{T}\alpha_{\tau}S_{\tau}}{\sum_{\tau=1}^{T}\alpha_{\tau}Y_{\tau}}\,, \tag{3}$$

where α_{τ} still denotes the population share of cohort τ, S_{τ} denotes the savings of cohort τ, and Y_{τ} the income of cohort τ.

We can call definition (i) the average household saving rate and definition (ii) the aggregate household saving rate. Clearly, if all cohorts have the same income levels and identical population shares, the two definitions are equivalent. However, if different cohorts have different income levels and population shares (e.g., because of income growth and population growth), the two measures of the aggregate saving rate are not identical. Because definition (ii) depends only on macro data and is consistent with the data presented in Figures 1 and 2, we adopt definition (ii) in equation (3) as the measure of the aggregate household saving rate for use throughout the rest of this paper.

Assume for a moment identical population shares across cohorts (we will relax this assumption in the next section); then $\alpha_{\tau}=\dfrac{1}{T}$ in equation (3). In this case, because income and housing prices are time invariant, we can compute the aggregate household saving rate in equation (3) using information provided in Table 1 to obtain

$$\overline{S}=\frac{\sum_{\tau=1}^{T}\frac{1}{T}S_{\tau}}{\sum_{\psi=1}^{T}\frac{1}{T}Y_{\tau}}=\frac{\left(\sum_{\tau=1}^{T}\frac{M}{T}\right)-M}{\sum_{\tau=1}^{T}\overline{Y}}=0\,. \tag{4}$$

Namely, the aggregate saving rate is zero and independent of housing prices.

Hence, under the maintained assumptions of constant income and demographics, changes in the level of housing prices do not affect the aggregate saving rate, although they do affect individuals' saving rates. In other words, even if 99% of the total population is saving for future home purchases, the other 1% (homebuyers) can generate just enough negative savings to cancel the would-be homebuyers' positive savings, resulting in a zero aggregate saving rate. This logic of aggregation is simple but not always recognized.

However, does the conclusion continue to hold if income and housing prices grow over time? In a sense, continuously rising housing prices imply that young cohorts must continuously increase their saving rate and save for a longer period to afford a house. Consequently, the relative population share of the would-be homebuyers will get larger than that of homebuyers (even without population growth) and this population effect may result in a higher aggregate saving rate, holding income constant. On the other hand, if income is also growing over time, the effective size of the would-be homebuyers relative to homebuyers will shrink because the need to save is reduced (a negative population effect), everything else equal. Therefore, if income and housing prices are growing at the same time, their population effects may (at least partially) cancel each other, leading to insignificant changes in the aggregate saving rate. This issue is the focus of the next subsection.

2.2 Time-Varying Income and Housing Prices

In a model with time-varying income and housing prices, a consumer born in period *1* who needs to purchase a house in period $t+1$ solves the following problem:

$$\text{max:} \sum_{\tau=1}^{T} u(C_\tau)$$

$$\text{s.t.:} \quad \sum_{\tau=1}^{T} C_\tau + M_{t+1} \leq \sum_{\tau=1}^{T} Y_\tau .$$

The optimal solution is given by

$$C_\tau = \overline{Y} - \frac{M_{t+1}}{T}.$$

where

$$\overline{Y} = \frac{1}{T}\sum_{\tau=1}^{T} Y_\tau$$

denotes a consumer's permanent income (i.e., average lifetime income). Total expenditure in period $t+1$ is $C + M_{t+1}$.

Suppose the optimal age for each consumer to become a homeowner is $t+1$ periods after birth. Suppose at the present moment this cohort of homebuyers faces housing price M_0 and has permanent income $\overline{Y}_0$. We call this age group "cohort $t+1$." Based on such notations, the generation one period younger than the homebuyer cohort is called "cohort t," who will become homebuyers in the next period and face housing price M_1 and permanent income $\overline{Y}_1$. Analogously, the generation one period older than the homebuyers is called "cohort $t+2$," who have already bought a house one period ago when the housing price was M_{-1} and permanent income was $\overline{Y}_{-1}$. By the same token, at the present moment all generations younger than the homebuyers are called cohorts $\{1, 2, \ldots, t\}$, respectively, and these would-be homebuyers will face housing prices $\{M_t, M_{t-1}, ..., M_1\}$ and permanent income $\{\overline{Y}_t, \overline{Y}_{t-1}, ..., \overline{Y}_1\}$, respectively. Also, at the moment all generations older than the homebuyers are called cohorts $\{t+2, t+3, \ldots, T\}$, respectively, and these homeowners once bought a house with prices $\{M_{-1}, M_{-2}, ..., M_{-T+t-1}\}$ and permanent income $\{\overline{Y}_{-1}, \overline{Y}_{-2}, ..., \overline{Y}_{-T+t-1}\}$ in the past.

Based on the above notations, we can tabulate the incomes, savings, and saving rates of different age cohorts at the present moment. The first row in Table 2 shows the age of different cohorts at the present moment, the second row their respective permanent income levels, the third row the housing prices they face when becoming a homeowner, the fourth row their current level of savings, and the last row their respective saving rate at the present moment. The table shows that at the same time point different age cohorts have different saving rates because permanent income and housing prices are changing over time. However, regardless of age cohort, the saving rate of each cohort is a function of the housing price-to-income ratio ($M/\overline{Y}$) facing that particular cohort.

Table 2. Saving Behavior of Different Age Cohorts

Age Cohort	***1***	**…**	***t***	***t+1***	***t+2***	**…**	***T***
Permanent Income	$\overline{Y}_t$	$\cdots$	$\overline{Y}_1$	$\overline{Y}_0$	$\overline{Y}_{-1}$	$\cdots$	$\overline{Y}_{-T+t+1}$
Housing Price	M_t	$\cdots$	M_1	M_0	M_{-1}	$\cdots$	M_{-T+t+1}
Savings	M_t/T	$\cdots$	M_1/T	$\frac{(1-T)M_0}{T}$	M_{-1}/T	$\cdots$	M_{-T+t+1}/T
Saving Rate	$\frac{M_t}{T\overline{Y}_t}$	$\cdots$	$\frac{M_1}{T\overline{Y}_1}$	$\frac{(1-T)M_0}{T\overline{Y}_0}$	$\frac{M_{-1}}{T\overline{Y}_{-1}}$	$\cdots$	$\frac{M_{-T+t+1}}{T\overline{Y}_{-T+t+1}}$

Therefore, if the price-to-income ratio $M/\overline{Y}$ remains constant over time despite growing housing prices and permanent income, then different age cohorts (except the homebuyer cohort) have the same saving rate, whereas the homebuyer cohort always has a negative saving rate. Hence, the average saving rate across cohorts is exactly zero because each cohort is weighted identically by the factor $1/T$ in computing the societal average saving rate.

However, because by definition the aggregate saving rate is the ratio of aggregate saving to aggregate income, instead of the weighted sum of individuals' saving rates, the measured aggregate saving rate is not necessarily zero but depends on the current housing price-to-aggregate income ratio. That is, the negative savings of the homebuyer cohort (cohort $t+1$) may receive a lower (or higher) weight than $1/T$ if equation (3) is used as our measure of the aggregate saving rate. For example, if the ratio of cohort $t+1$'s housing price (M_0) to aggregate income equals $1/T$, then the measured aggregate saving rate is still zero; however, if that ratio is greater than $1/T$, then the measured aggregate saving rate is less than zero because the negative savings caused by the homebuyer cohort more than cancels the total savings from other cohorts due to time-varying housing prices and income; and if that ratio is less than $1/T$, the measured aggregate saving rate is positive.

To sort out these effects, consider first the case where permanent income and housing prices have constant growth rates according to the law of motion: $\overline{Y}_\tau = (1+a)\overline{Y}_{\tau-1}$ and $M_\tau = (1+b)M_{\tau-1}$, respectively, where the growth rate a and b are both constants. Notice that if annual income grows at a constant rate, then the permanent income also grows at the same constant rate. Under these conditions, the aggregate saving rate is given by

$$\overline{S} = \frac{\sum_{\tau=-T+t+1}^{t} \frac{1}{T} S_\tau}{\sum_{\tau=-T+t+1}^{t} \frac{1}{T} Y_\tau} = \frac{\left(\sum_{\tau=-T+t+1}^{t} \frac{M_0 (1+b)^\tau}{T} \right) - M_0}{\sum_{\tau=-T+t+1}^{t} \overline{Y}_0 (1+a)^\tau}. \tag{5}$$

If $a \neq 0$ and $b \neq 0$, equation (5) can be simplified to

$$\overline{S} = \frac{M_0}{\overline{Y}_0} \frac{\frac{(1+b)^{-T+t+1}}{T} \frac{\left[1-(1+b)^T\right]}{1-(1+b)} - 1}{(1+a)^{-T+t+1} \frac{\left[1-(1+a)^T\right]}{1-(1+a)}},$$

which depends only on the price-to-income ratio of the current homebuyer cohort.

For example, suppose $a = b = 10\%$, $T = 40$, and $t = 15$.[12] Then equation (5) gives an aggregate saving rate of 2.14%, which is trivial compared with the 20% Chinese aggregate saving rate. On the other hand, it is possible to obtain an aggregate saving rate of 20% in the model if we allow the growth rate of permanent income and housing prices to be 50% per year, which is hard to imagine in reality. Therefore, when housing prices and permanent income grow at the same rate, housing prices are still irrelevant to the aggregate saving rate.

[12] $T = 40$ and $t = 15$ imply that each individual needs to work for 15 years to afford a house and work for 40 years to retire (income is assumed to be zero after retirement).

Calibration 1. We now use actual Chinese data to calibrate the model. Suppose that people start working at age 21 and retire at age 60; thus, we set the total working years $T = 40$. Also suppose that the average homebuyer's age is 35—that is, people must work and save for 15 years before buying a house. This implies that $t = 15$ in our model (e.g., in Table 2). Suppose that individuals in the homebuyer cohort ("cohort $t+1$") become homeowners in the year 2007; in that year the housing price-to-income ratio in China was 7.93, so we set $M_0 / Y_0 = 8$. According to Chinese Statistical Yearbook (2008), from 1978 to 2007 the growth rate of average family income is 12.57% in rural areas and 13.58% in urban areas; hence we set $a = 0.13$. According to Zhong Hong Macro Database, the average growth rate of housing prices was 9.02% per year between 1991 and 2008, hence we set $b = 0.09$. Entering these numbers into equation (5), the estimated aggregate saving rate equals 1%. That is, rising housing prices explain only 1 percentage point of China's aggregate household saving rate, substantially below the actual 27% saving rate in 2007.

Moreover, even if the growth rate of housing prices exceeds that of income, the impact of rising housing prices on aggregate saving rate is still quite limited. For example, when the growth rate of household income is 10% per year, to reach an aggregate saving rate of 20% in the model, the average growth rate of housing prices must be almost 20% per year. Although a 20% annual growth rate in housing prices is possible for a short period, we have not seen such a high average growth rate over a 10-year period in China or anywhere else in the world.

Calibration 2. The above calibration analysis is based on the assumption that the growth rates of income and housing prices are constant over time. If we allow the growth rate of income and housing prices to vary over time, how does this affect our results? Because the simple model is no longer analytically tractable under uncertainty, we assume perfect foresight to gain intuition. When the growth rates of both income and housing prices are time varying, Table 2 implies that the aggregate household saving rate is determined by

$$\overline{S} = \frac{\frac{1}{T}\sum_{\tau=-T+t+1}^{t} M_\tau - M_0}{\sum_{\tau=-T+t+1}^{t} \overline{Y}_\tau}. \tag{6}$$

As before, using 2007 as the base year for current homebuyers (cohort $t+1$): $M_0 = P_{2007}$, where P_{2007} denotes the average housing price in 2007. Recall that we use a 40-year window to compute the permanent income based on 40 years of average household income between year $2007-t$ and year $2007+T-t-1$, where T = 40. For example, the permanent income of cohort $t+1$ is given by $\overline{Y}_0 = \frac{1}{T}\sum_{j=2007-t}^{2007+T-t-1} Y_j$.

By the same method, we can also estimate the permanent incomes of cohorts $\{1,2,\ldots,t\}$ and cohorts $\{t+2,t+3,\ldots,T\}$.[13] Entering the estimated values of housing prices facing homebuyers of different age cohorts, $\{M_t, M_{t-1},\ldots,M_0,\ldots,M_{-T+t+1}\}$, and the corresponding permanent incomes $\{\overline{Y}_t,\overline{Y}_{t-1},\ldots,\overline{Y}_0,\ldots,\overline{Y}_{-T+t+1}\}$ into equation (6), we obtain an aggregate saving rate of 0.61%.

Therefore, regardless of how the model is calibrated, we conclude that in the absence of borrowing constraints, rising housing prices cannot explain China's aggregate household saving rate.

3 Borrowing Constraints and Demographics

The basic model in Section 2 makes two important assumptions: (i) Consumers can completely smooth their consumption over a working lifetime by using future income to finance current mortgage payments. (ii) The population or demographic structure does not change over time. These assumptions are not realistic and may bias our results.

Assumption (i) would be innocuous if household income, housing prices, and

[13] Computing young cohorts' permanent income needs to use income data after 2009. Since such data do not exist, we extrapolate by assuming a 10% annual growth rate after 2009. We provide the sensitivity analysis in Section 4.

population were constant over time. To understand this, suppose consumers cannot borrow at all. Then cohort $t+1$ must increase its saving rate at a younger age to accumulate just enough money to pay off the entire mortgage before period $t+1$. Even in this case, if income and housing prices do not grow over time, the aggregate saving rate is still zero because the negative savings generated by cohort $t+1$ in the housing market still completely cancel the total positive savings from cohorts $\{1,2,\ldots,t\}$.

However, if income and housing prices grow over time, assumption (i) is no longer innocuous and borrowing constraints may greatly magnify the positive impact of housing prices on the aggregate saving rate.

The assumption of a constant population size does not allow our model to capture any transitional dynamics outside the steady state. Hence, considering the demographic structure is also important for the robustness of our analysis and conclusions. Formal analyses with the assumptions (i) and (ii) relaxed are presented below. We consider first the case with borrowing constraints (Section 3.1) and then consider the case with a time-varying population structure (Section 3.2).

3.1 Borrowing Constraints

To facilitate future analysis, we first consider constant income and housing prices under borrowing constraints. If agents cannot borrow at all, assuming that the optimal period for home purchase is still $t+1$ periods after birth (we examine the robustness of the results to this assumption later), would-be homebuyers must then increase their saving rates before period $t+1$. This implies that from period 1 to t the saving rate is M/t, optimal consumption is $\overline{Y}-M/t$. Between period $t+2$ and period T, the optimal consumption level is $\overline{Y}$ and the saving rate is zero. In period $t+1$, total expenditure (consumption plus housing purchase) is $\overline{Y}+M$. These statistics are summarized in Table 3.

Table 3. Individual Saving Behavior under Borrowing Constraints

(Constant Income and Housing Prices)

Period	1	…	t	t+1	t+2	…	T
Expenditure	$\bar{Y} - M/t$	…	$\bar{Y} - M/t$	$\bar{Y} + M$	$\bar{Y}$	…	$\bar{Y}$
Saving	M/t	…	M/t	$-M$	0	…	0
Saving Rate	$\frac{M}{t\bar{Y}}$	…	$\frac{M}{t\bar{Y}}$	$\frac{-M}{\bar{Y}}$	0	…	0

Compared with Table 1, borrowing constraints raise the individual's saving rate from M/T to M/t; however, the average lifetime saving rate is still zero. Hence, if the population share of each age cohort is the same, the aggregate saving rate is also zero.

Now with time-varying income and housing prices, the effective share of each cohort is no longer the same because of the population effect. In this case, we can use a method similar to that used for Table 2 to compute each age cohort's saving rate under borrowing constraints. The results are summarized in Table 4.

Table 4. Saving Behavior of Different Cohorts under Borrowing Constraints

(Time-Varying Income and Housing Prices)

Age Cohort	1	…	t	t+1	t+2	…	T
Permanent Income	$\bar{Y}_t$	…	$\bar{Y}_1$	$\bar{Y}_0$	$\bar{Y}_{-1}$	…	$\bar{Y}_{-T+t+1}$
Housing Price	M_t	…	M_1	M_0	M_{-1}	…	M_{-T+t+1}
Saving	M_t/t	…	M_1/t	$-M_0$	0	…	0
Saving Rate	$\frac{M_t}{t\bar{Y}_t}$	…	$\frac{M_1}{t\bar{Y}_1}$	$\frac{-M_0}{\bar{Y}_0}$	0	…	0

Each generation purchases houses $t+1$ periods after birth. In a particular moment, the current homebuyer generation is called cohort $t+1$, and this cohort faces housing price M_0 and permanent income $\overline{Y}_0$. The one-period-younger generation is called cohort t, this cohort will be buying houses in the next period, facing housing price M_1 and permanent income $\overline{Y}_1$, and this generation's current saving rate is M_1/t. Analogously, the one-period-older generation is called cohort $t+2$, these individuals have already bought houses in the last period, faced housing price M_{-1} and permanent income $\overline{Y}_{-1}$, and this generation's current saving rate is 0, in contrast to the model in Table 2. All cohorts proceed in a similar fashion.

Suppose the laws of motion for permanent income and housing prices are given, respectively, by $\overline{Y}_\tau = (1+a)\overline{Y}_{\tau-1}$ and $M_\tau = (1+b)M_{\tau-1}$, where the growth rates a and b are both constant. Under such conditions, the aggregate saving rate is given by

$$\overline{S} = \frac{\sum_{\tau=1}^{t} \frac{M_0(1+b)^\tau}{t} - M_0}{\sum_{\tau=-T+t+1}^{t} \overline{Y}_0(1+a)^\tau}, \tag{7}$$

which can be simplified to

$$\overline{S} = \frac{M_0}{\overline{Y}_0} \frac{\frac{(1+b)}{t}\frac{\left[1-(1+b)^t\right]}{1-(1+b)} - 1}{(1+a)^{-T+t+1}\frac{\left[1-(1+a)^T\right]}{1-(1+a)}}.$$

It can be shown that the aggregate saving rate under borrowing constraints is larger than that without borrowing constraints. The intuition is as follows. Without borrowing constraints, when housing prices increase, the average saving rate of would-be homebuyers is larger than that of the homeowners because of the population effect. With borrowing constraints, this population effect is significantly amplified because the saving rate of all homeowners is now zero. In other words, in computing the aggregate savings, the population weight of would-be homebuyers is increased from $1/T$ to $1/t$, while the population weight of the homeowners is decreased from

$1/T$ to 0. Because the aggregate income of all cohorts is the same, the ratio of aggregate savings to aggregate income (the aggregate saving rate) has increased under borrowing constraints.

Calibration. As in the previous analysis in Section 2.2, set $T = 40$, $t = 15$, $M_0/\overline{Y}_0 = 8$, $a = 0.13$, and $b = 0.09$. Substituting these values into equation (7) gives an aggregate saving rate of 16.66%. Alternatively, if we allow the growth rate of income and housing prices to vary over time (as in actual Chinese data), under the assumption of perfect foresight, the aggregate saving rate is given by:

$$\overline{S} = \frac{\dfrac{\sum_{\tau=1}^{t} M_\tau}{t} - M_0}{\sum_{\tau=-T+t+1}^{t} \overline{Y}_\tau}. \tag{8}$$

Using the same method adopted in Section 2.2—namely, choosing 2007 as the base year for the current homebuyers (cohort $t+1$), estimating and computing the associated values for housing prices $\{M_t, M_{t-1}, \ldots, M_0, \ldots, M_{-T+t+1}\}$ and permanent incomes $\{\overline{Y}_t, \overline{Y}_{t-1}, \ldots, \overline{Y}_0, \ldots, \overline{Y}_{-T+t+1}\}$, and substituting the results into equation (8) gives an aggregate saving rate of 19.22%, higher than that implied by equation (7).

Clearly, under severe borrowing constraints (i.e., no borrowing at all), using actual Chinese time-series data for housing prices and income implies estimates of the aggregate saving rate that matches the actual Chinese household saving rate quite well. It thus appears that rising housing prices can explain China's high household saving rate if borrowing constraints are taken into account. Or is it so?

Not really. In reality, the degrees of borrowing constraints are not as severe as assumed in the previous analysis. Typically, homebuyers only need to pay one-third of the housing price as a down payment and can borrow at least two-thirds with the mortgage. The question is, how would a slightly relaxed borrowing constraint affect our quantitative result?

To be conservative, assume that the down-payment requirement is as high as

50% of the house.[14] In this case, the borrowing constraints do not bind if each generation's optimal time for buying a house is after working for 20 years (because of sufficient savings). However, as long as each generation still needs to purchase houses after working only for 15 years (as assumed before), borrowing constraints will still bind for every generation with an empirically plausible growth rate of income and housing prices. Under these conditions, a typical individual's saving behavior is shown in Table 5.

Table 5. Individual's Saving Behavior with 50% Down Payment

Period	***1***	**…**	***t***	***t+1***	***t+2***	**…**	***T***
Expenditure	$\overline{Y}-M/t$	…	$\overline{Y}-M/t$	$\overline{Y}+M$	$\overline{Y}$	…	$\overline{Y}$
Saving	$M/2t$	…	$M/2t$	$\frac{M}{2(T-t)}-M$	$\frac{M}{2(T-t)}$	…	$\frac{M}{2(T-t)}$
Saving rate	$\frac{M}{2t\overline{\overline{Y}}}$	…	$\frac{M}{2t\overline{\overline{Y}}}$	$\frac{M}{2(T-t)\overline{\overline{Y}}}-\frac{M}{\overline{\overline{Y}}}$	$\frac{M}{2(T-t)\overline{\overline{Y}}}$	…	$\frac{M}{2(T-t)\overline{\overline{Y}}}$

As Table 5 shows, between period 1 and period t of an individual's lifetime, a consumer's annual saving is $M/2t$; in period $t+1$, the total past savings are just enough to pay for the 50% down payment, so the consumer needs to borrow the other 50% from future income to pay for the mortgage. Thus, in period $t+1$ the buyer's housing expenditure is M and saving is $\frac{M}{2(T-t)}-\mathrm{M}$; afterward, future saving each period is always $\frac{M}{2(T-t)}$.

Based on such information and assuming time-varying income and housing prices, we can use the methods outlined in the previous sections to compute each cohort's saving rate at the same moment (Table 6).

[14] In China the down payment required for home loans has been about one-third of the purchase price until very recently. Now the down payment for the first house is one-third and that for the second house is 50%.

Table 6. Saving Behavior of Different Cohorts with 50% Down Payment

Age Cohort	*1*	…	*t*	*t+1*	*t+2*	…	*T*
Permanent Income	$\overline{Y}_t$	…	$\overline{Y}_1$	$\overline{Y}_0$	$\overline{Y}_{-1}$	…	$\overline{Y}_{-T+t+1}$
Housing Price	M_t	…	M_1	M_0	M_{-1}	…	M_{-T+t+1}
Saving	$M_t/2t$	…	$M_1/2t$	$\frac{M_0}{2(T-t)}-M_0$	$\frac{M_{-1}}{2(T-t)}$	…	$\frac{M_{-T+t+1}}{2(T-t)}$
Saving Rate	$\frac{M_t}{2t\overline{Y}_t}$	…	$\frac{M_1}{2t\overline{Y}_1}$	$\frac{M_0}{2(T-t)\overline{Y}_0}-\frac{M_0}{\overline{Y}_0}$	$\frac{M_{-1}}{2(T-t)\overline{Y}_{-1}}$	…	$\frac{M_{-T+t+1}}{2(T-t)\overline{Y}_{-T+t+1}}$

In Table 6, if permanent income and housing prices follow a constant growth rule, $\overline{Y}_\tau=(1+a)\overline{Y}_{\tau-1}$ and $M_\tau=(1+b)M_{\tau-1}$, then the aggregate saving rate is given by

$$\overline{S}=\frac{\sum_{\tau=1}^{t}\frac{M_0(1+b)^\tau}{2t}+\sum_{\tau=-T+t+1}^{0}\frac{M_0(1+b)^\tau}{2(T-t)}-M_0}{\sum_{\tau=-T+t+1}^{t}\overline{Y}_0(1+a)^\tau}. \tag{9}$$

In such a case, we use Chinese data to set $T=40$, $t=15$, $M_0/\overline{Y}_0=8$, a=0.13, and $b=0.09$. Substituting these values into equation (9) gives an aggregate saving rate of 4.17%.

On the other hand, if the growth rates of income and housing prices are time varying, the aggregate saving rate is given by

$$\overline{S}=\frac{\frac{\sum_{\tau=1}^{t}M_\tau}{2t}+\frac{\sum_{\tau=-T+t+1}^{0}M_\tau}{2(T-t)}-M_0}{\sum_{\tau=-T+t+1}^{t}\overline{Y}_\tau}. \tag{10}$$

Using the same method as before, by setting 2007 as the base year for homebuyers (cohort $t+1$) and computing the associated housing prices $\{M_t,M_{t-1},\ldots,M_0,\ldots,M_{-T+t+1}\}$ and permanent incomes $\{\overline{Y}_t,\overline{Y}_{t-1},\ldots,\overline{Y}_0,\ldots,\overline{Y}_{-T+t+1}\}$, equation (1) implies an aggregate saving rate of 4.34%.

Therefore, from the above analyses we can make the following conclusions:

Borrowing constraints can significantly amplify the positive effects of housing prices on the aggregate saving rate. However, as long as the borrowing constraints are not too severe (i.e., with a 50% down payment),[15] the effects of rising housing prices on the aggregate saving rate are minimal.

Our analysis also indicates that, relative to rising housing prices and other costs of living, borrowing constraints may be a more important and essential factor for China's high household saving rate. This also explains why rising housing prices in the United States for more than a decade before the recent financial crisis did not induce a high household saving rate: American families are much less borrowing constrained than Chinese households. Our conclusion is consistent with the analysis of Wen (2009), who shows in a general-equilibrium growth model that borrowing constraints not only induce a high precautionary saving rate under income uncertainty but also make this precautionary saving rate an increasing function of income growth. So a high income growth can lead to a high aggregate saving rate under borrowing constraints and income uncertainty.

3.2 Demographics

Similar to the cases of income and housing price changes, a changing population should have no impact on the aggregate saving rate without borrowing constraints. Thus, this section considers only the cases with borrowing constraints.

If the population changes over time, the population weights α_τ in equation (3) for different cohorts must be adjusted accordingly when computing the aggregate saving rate. Thus, letting W_τ denote cohort τ's share in total population and assuming that permanent income and housing prices follow the laws of motion, $\overline{Y}_\tau = (1+a)\overline{Y}_{\tau-1}$ and $M_\tau = (1+b)M_{\tau-1}$, then the aggregate saving rate based on equation (3) is given by

[15] The actual down-payment requirement in China is less than 50%. Assuming a smaller value further reduces the impact of housing prices on aggregate saving rate.

$$\bar{S} = \frac{\sum_{\tau=1}^{t} W_\tau \frac{M_0(1+b)^\tau}{t} - W_0 M_0}{\sum_{\tau=-T+t+1}^{t} W_\tau \bar{Y}_0 (1+a)^\tau}, \tag{11}$$

which is analogous to equation (7).

Based on the population shares of age 21 to age 60 provided in China Population and Employment Statistics Yearbook (2008), assuming that working ages are from 21 to 60, the average homebuyer's age is 35 (i.e., he or she must work for 15 years to buy a house), using the average income growth and housing price growth in China, equation (11) implies an aggregate saving rate of 10.47%, lower than the value under constant population. If we allow a 50% down payment for the mortgage, the implied aggregate saving rate is negative (-0.75%), also lower than the value with constant population.

If we allow the growth rates of income and housing prices to be time varying, under 100% borrowing constraints (100% down payment), the aggregate saving rate is given by

$$\bar{S} = \frac{\sum_{\tau=1}^{t} W_\tau \frac{M_\tau}{t} - W_0 M_0}{\sum_{\tau=-T+t+1}^{t} W_\tau \bar{Y}_\tau}. \tag{12}$$

Using a similar calibration method as in the previous section by choosing 2007 as the base year for the homebuyer cohort, the implied aggregate saving rate is 11.32%, lower than the value with constant population. If we allow a 50% down payment, the implied aggregate saving rate is -1.62%, also lower than the value with constant population.

The reason that consideration of demographic structure yields a lower aggregate saving rate, everything else equal, is that in recent years the homebuyer cohort is at its peak in terms of its population share. Therefore, the savings generated by this cohort receives larger weight. Figure 3 plots the demographic structure in China based on China Population and Employment Statistics Yearbook (2008), under the assumption that working ages are between 21 and 60 and the average homebuyer's age is 35.

Figure 3 shows that the homebuyer cohort peaked around 2007.

Suppose the base year of the homebuyer cohort is moved to other years, such as 2005 or earlier, or if we change the assumed age of homebuyers, the implied aggregate saving rate will be only insignificantly different from the value obtained earlier under the assumption of constant population. The reason is simple: Unless the population has been sharply declining so that the population share of the homebuyer cohort is always significantly larger than that of the would-be homebuyer cohorts (which is inconsistent with Chinese data), taking the demographic structure into account cannot strengthen the effect of rising housing prices on the aggregate saving rate.

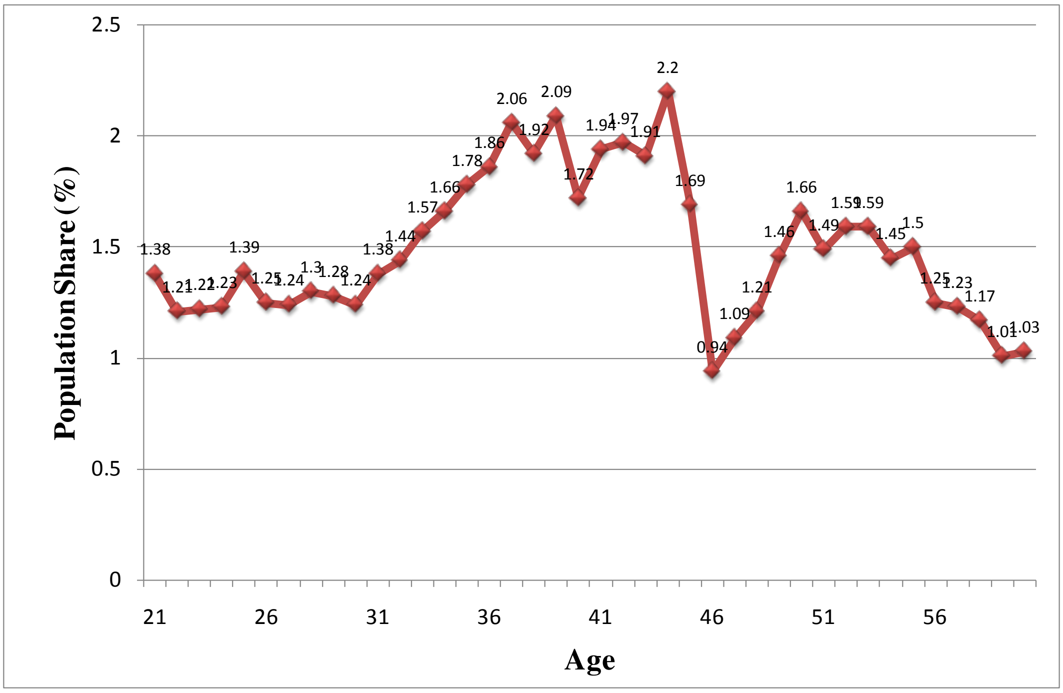

Figure 3. Population Shares of Different Age Cohorts in 2007 (Data source: China Statistics Yearbook).

3.3 Summary

We have discussed three scenarios in the previous analyses: (a) time-varying income and housing prices, (b) borrowing constraints, and (c) demographic changes.

The results are briefly summarized in Table 7. The first column lists the assumptions, the second column shows the corresponding equation used to compute the aggregate saving rate, and the last column shows the numerical value of the aggregate saving rate.

Table 7. Aggregate Saving Rate under Different Assumptions

Assumptions	**Equation**	**Saving Rate**(%)
No BC, constant {D, I, P}	(4)	0.00
No BC, constant D, constant growth in {I, P}	(5)	1.00
No BC, constant D, time-varying growth in {I,P}	(6)	0.61
100% BC, constant D, constant growth in {I,P}	(7)	16.66
100% BC, constant D, time-varying growth in {I,P}	(8)	19.22
50% BC, constant D, constant growth in {I,P}	(9)	4.17
50% BC, constant D, time-varying growth in {I,P}	(10)	4.34
Time-varying D, 100% BC, constant growth in {I,P}	(11)	10.47
Time-varying D and growth in {I,P}, 100%BC	(12)	11.32
Time-varying D, 50% BC, constant growth in {I,P}		-0.75
Time-varying D and growth in {I,P}, 50% BC		-1.62

Note: BC stands for borrowing constraints, D for population, I for income, P for housing prices, and 100% BC for full down-payment.

The first three rows in Table 7 show that without borrowing constraints and demographic changes, rising housing prices contribute very little to the aggregate saving rate: less than 1%. The subsequent two rows show that under complete borrowing constraints (with zero possibility to borrow), rising housing prices can have very large effects on aggregate saving rate, ranging from 16.66% to 19.22%. However, such effects are quickly dampened once the degree of borrowing constraints is reduced. For example, with a 50% down-payment requirement, the aggregate saving rate is reduced to 4.17% and 4.34%, respectively, depending on the specific income process. In addition, if China's demographic structure is taken into account, the last two rows in the table show that the saving rate is reduced further: down to -0.75% and -1.62%, respectively. Therefore, we can conclude that, given Chinese time-series data on household income, mortgage prices, borrowing costs, and demographics, the aggregate household saving rate is essentially unrelated to housing prices.

4 More Sensitivity Analyses

4.1 Different Extrapolations

In the previous analyses, we extrapolated the future growth rates of permanent income and housing prices beyond 2009 when considering the effects of time-varying income and housing prices. For example, in equation (10) we have assumed that future growth rates of income and housing prices are both 10% per year after 2009. In the following, we conduct sensitivity analyses on equation (10) by considering other possible growth rates for future income and housing prices. Assume a 50% down payment requirement and that the future growth rates of income and housing prices take the values of {8%, 9%, 10%, 11%, 12%}, respectively. The implied aggregate saving rates under these possible future growth rates for income and housing prices are reported in Table 8, where the top panel assumes a constant demographic structure and the bottom panel considers a time-varying population.

Table 8. Sensitivity Analysis for Different Future Growth Rates

(50% Down Payment)

	Expected Housing-Price Growth				
	8%	9%	10%	11%	12%
Expected Income Growth	**Constant Population**				
8%	1.81%	3.24%	4.79%	6.48%	8.34%
9%	1.73%	3.09%	4.57%	6.19%	7.95%
10%	1.64%	2.93%	4.34%	5.87%	7.55%
11%	1.55%	2.77%	4.10%	5.55%	7.13%
12%	1.46%	2.60%	3.85%	5.22%	6.70%
	Time-Varying Population				
8%	-4.44%	-3.16%	-1.77%	-0.25%	1.40%
9%	-4.26%	-3.04%	-1.70%	-0.24%	1.35%
10%	-4.07%	-2.90%	-1.62%	-0.23%	1.29%
11%	-3.87%	-2.76%	-1.55%	-0.22%	1.23%
12%	-3.67%	-2.61%	-1.46%	-0.21%	1.16%

First, Table 8 shows that, given the growth rate of housing prices, the aggregate saving rate decreases as the growth rate of income rises. This is consistent with the permanent-income hypothesis. Second, the aggregate saving rate increases when housing prices are growing faster, given the income growth. The main reason for this is the existence of borrowing constraints. Third, the aggregate saving rate is the highest (as high as 8.34%) when the expected future income growth rate is 8% and that of housing prices is 12%. However, if we reduce the down-payment requirement from one-half to one-third, the aggregate saving rate becomes essentially zero. Even if the down payment remains 50%, taking into account China's demographic structure (lower panel in Table 8) also reduces the implied aggregate saving rate from 8.34% to 1.40%.

Therefore, unless people expect housing prices to grow much faster than 12% per year, that future income growth is significantly lower than 8% a year, and that the borrowing constraints are more severe than the 50% down-payment requirement, housing prices cannot explain China's high aggregate household saving rate.

4.2 Other Possible Extensions

Our analysis so far is based on a simple economic model. However, our simple model can be further enriched. In this section we discuss some possible extensions and the likely effects of such extensions on our results.

(a) Making the Timing of Home Purchase Endogenous

The optimal timing of home purchase t in our model is exogenous and is calibrated using the average homebuyer's age (working years). If we can make this variable endogenous, the model has the potential to explain the difference in the optimal age of homebuyers across countries. However, even if this variable is endogenized, we still need to calibrate the other parameters so that the model-predicted timing of home purchase matches that in the data. This is not much different from exogenously setting $t = 15$, as we did in this paper. Therefore, even if t were endogenous, our results would still hold under similar calibrations.

(b) Including Wealth Effects

In our simple model housing is a consumption good and generates a constant lifetime utility. In reality, housing is also a capital good because it may yield capital gains when housing prices appreciate, which may generate positive wealth effects. However, this simplification does not hurt our analysis. If shelters were introduced into our model as a capital good (or durable consumption good), the situation is the same for the would-be homebuyer cohorts when housing price increases; but for the homeowners, it implies that their wealth would increase, which would decrease their saving incentives and mitigate the positive impact of rising housing prices on lifetime savings. Such a wealth effect may explain why the aggregate household saving rate in developed countries has been declining in the past decade. For example, Case, Quigley, and Shiller's (2006) empirical analysis based on cross-country and cross-state data for the United States finds that for every 10% increase in housing prices, the consumption-to-income ratio increases by 1.1% and the saving rate decreases by 1.1%. These authors explain their findings based on the wealth effect. Hence, introducing a wealth effect into our model would only strengthen our conclusion that rising housing prices cannot explain China's high aggregate saving rate.

(c) The Hump-Shaped Curve of Lifetime Income

Our model assumes that household income is either constant or increasing over time. But in reality income follows a life cycle with an inverted-U shape: Personal income peaks in middle age. However, our results are not sensitive to this income pattern. First, in our model the measured income is household or family income, not individual income. Household income is less hump-shaped than individual income unless both husband and wife are identical wage earners. Second and more importantly, the most important concern for a hump-shaped income profile is that agents are more borrowing constrained at a young age. But in our model we have set the optimal age of home purchase as 35 (i.e., 15 years after start working), which is roughly the peak year of lifetime income. Thus, our calibration makes the concern of borrowing constraints due to a hump-shaped income pattern less relevant. In addition, our calibration of the down-payment requirement of 50% has effectively overestimated the actual degree of borrowing constraints; we showed that even under a 50% down-payment requirement the influences of rising housing prices on the aggregate saving rate is insignificant. Hence, taking into account the inverted-U curve of lifetime income should not change our results significantly.

(d) Bequests

In China, many parents give money to their children to buy houses because the children cannot afford the high mortgage costs. Hence, a popular view is that this type of altruism raised China's aggregate saving rate. We can use a version of our simple model to show that this view is incorrect because it again suffers from the fallacy of aggregation. The intuition is simple: Bequests from parents reduce their children's need to save; hence, at the aggregate level bequests have little effect on the average household saving rate.

In particular, under borrowing constraints, bequests can even reduce the positive impact of housing prices on the aggregate saving rate when both income and housing prices are increasing over time. The reason is as follows. Suppose each generation receives a bequest at birth from their parents and leaves an identical amount of bequest at death to their children. This chain of overlapping-generation bequests effectively allows a consumer to borrow against future income because bequests resemble lump-sum subsidies when young and lump-sum taxes when old. Hence, bequests effectively reduce the borrowing constraints of each generation. So rapidly increasing housing prices will have less effect on the aggregate saving rate in an economy with bequests.

5 Conclusions

Our analysis shows that (i) without borrowing constraints and population growth, the aggregate household saving rate is essentially independent of rising housing prices. (ii) Accounting for China's demographic reduces the aggregate saving rate because the ratio of homebuyers to non-homebuyers has been increasing, which enlarges the weights of the negative savings of the homebuyers in aggregate savings. (iii) Under borrowing constraints the aggregate saving rate can become quite sensitive to housing prices; however, with realistic degrees of borrowing constraints (such as allowing for a 50% down payment), rising housing prices can generate a aggregate saving rate of 4.17% without considering the Chinese demographic structure (this value becomes zero if the demographic structure is taken into account). These values are too small to explain China's 20% aggregate saving rate.

Therefore, our analysis clarifies a popular misunderstanding or fallacy that attributes the rapidly rising costs of living, such as housing, education, healthcare, and so on to China's high aggregate household saving rate. This view ignores the saving-expenditure cancellation effect across cohorts.

If the rapidly rising housing prices and other costs of living are not responsible for the high Chinese saving rate, what are the actual causes of such saving? Our analysis of borrowing constraints provides some hint: If people cannot borrow against their future income, they must increase their savings when they are young to afford the same level of expenditures in the future, which leads to a higher aggregate saving rate through the "population effect" that effectively increases the population weights of the saving cohorts relative to the dissaving cohorts (as if the population were growing rapidly). Thus, we believe that future research that takes both borrowing constraints and income uncertainty into account may prove fruitful in explaining China's high aggregate saving rate. Wen (2009) provides a first step toward this direction.

Our findings also have some policy implications. Although rapidly rising housing prices may have adverse welfare effects on would-be homebuyers, policies that are designed to reduce housing prices will reduce young people's individual saving rate but will not be effective in reducing the aggregate saving rate. In comparison, policies designed to reduce borrowing constraints and improve the efficiency of the financial system may prove more effective in reducing the aggregate saving rate.

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